

Needs assessment in hidden populations using respondent-driven sampling

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One of the primary methods for identifying relevant evaluative criteria or dimensions of merit for evaluating programs is assessing the needs of a program's target population. These criteria, or dimensions, are the attributes of the evaluand, which are used for determining how good or how effectively a program is meeting the target population's needs. However, identifying relevant criteria for many human and social service programs, especially those serving hidden populations (e.g. injection drug users, HIV-positives, homosexuals, prostitutes, and the homeless), poses numerous practical and methodological challenges. Using a case study approach, this article describes how Heckathorn's (1997) respondent-driven sampling (RDS) was used to access and draw estimates from the homeless population in a mid-sized urban community in the United States as part of an evaluation that included assessing the population's performance needs, gathering baseline data, and as one source for identifying the relevant criteria by which the program was evaluated.

Keywords: needs assessment, hidden populations, evaluative criteria, sampling

Introduction

In order to comprehensively evaluate any program, one of an evaluator's most important activities is identifying relevant evaluative criteria or dimensions of merit (Coryn 2007; Davidson 2005; Scriven 1991, 2004). These criteria are the 'attributes (e.g. features, impacts) of the evaluand', which allow evaluators 'to see how good (or how valuable, how effective, etc.) it is' (Davidson 2005, p. 23). Often these criteria include dimensions identified or derived from organizational goals and objectives, professional standards of quality, legal and ethical requirements, and so forth (Scriven 1991, 2004). Some (Mark 2003; Mark, Henry & Julnes 2000; Renger & Bourdeau 2004) advocate a stakeholder approach to identifying and developing these criteria (i.e. values inquiry), often, but not always, excluding a program's actual and potential consumers. Yet, some of the most important dimensions of merit are those that give emphasis to a program's target population.

Identifying relevant evaluative criteria

Numerous strategies are available, one of which is assessing the needs of the target population (Altschuld & Witkin 2000; Chen 2005; Davidson 2005;

Scriven 2004; Witkin & Altschuld 1995). Needs assessments may be viewed as an alternative or auxiliary approach to values inquiry (Renger & Bourdeau 2004); although, some (Davidson 2005; Scriven 2004) view needs assessments as one of the primary sources of merit dimensions by which programs are to be evaluated. Needs then, as used here, are 'something without which unsatisfactory functioning occurs' (Davidson 2005, p. 33). Discovering the true needs of a program's actual and potential consumers includes identifying met and unmet, conscious and unconscious, and instrumental and performance needs (Davidson 2005; Scriven 2004). Assessing needs requires a long-term outlook. For example, a smoker may 'need' a cigarette in order to avoid withdrawal symptoms; however, in the long-run they are better off without the cigarette. Likewise, needs must be evaluated within a contextual framework. During the Civil Rights Era, many African-Americans in the United States sacrificed their safety to attain the personal freedoms and respect due to every citizen. These examples highlight the fact that some needs are more important than others.

Once identified, needs may be used to develop explicit criteria and rubrics by which evaluators can determine how well a program is meeting those needs. Unfortunately, assessing the needs of programs that serve a hidden target population poses numerous practical and methodological challenges because collecting accurate information about group members is simply not possible with traditional sampling and estimation techniques (Department of Human Services 2002; Salganik & Heckathorn 2004). These populations include for example, injection drug users, individuals who are HIV-positive, homosexuals, prostitutes, and individuals who are homeless. Standard sampling and estimation procedures require sampling from a known frame (Kish 1995; Lohr 1998). For hidden populations a known sampling frame simply does not exist (Salganik & Heckathorn 2004). Furthermore, constructing a frame for these groups is unlikely due to the likely small size of the target population within the broader population, difficulty locating members of these populations, and the desire by many of the population's members to remain unidentified (Salganik & Heckathorn 2004). Moreover, even if a frame could be constructed, a broad random sample of the overall population would not be cost-effective given the low base rate of such groups in the overall population. Likewise, the social stigma associated with membership in some of these hidden groups (e.g. HIV/AIDS) may further reduce the likelihood that people will respond with candor.

In an effort to address these difficulties Heckathorn developed respondent-driven sampling (RDS) as part of a National Institute on Drug Abuse-funded HIV-prevention research project targeting drug injectors in several American cities (Heckathorn 1997; Heckathorn et al. 2002; Lang 2004). RDS has been applied to study a variety

of populations, such as jazz musicians in New York, San Francisco, New Orleans, and Detroit (Heckathorn & Jeffri 2003; Lang 2004), injection drug users in Bangkok (Centers for Disease Control and Prevention 2005; Lang 2004), injection drug users and prostitutes in Vietnam (Centers for Disease Control and Prevention 2005; Lang 2004), and in more than a dozen other countries (Family Health International 2005; Lang 2004).

Here, the RDS methodology is illustrated through a case study in which the needs of the homeless in a mid-sized American urban community were assessed. Traditionally, RDS has been used to estimate prevalence within a population. In the case study presented, this was but one of several purposes for employing the methodology. Other purposes included identifying relevant evaluative criteria from needs (primarily performance needs¹) and collecting baseline data for monitoring changes on critical outcome variables by using RDS as a method for accessing the target population. Thus, this article has a twofold purpose: (1) to introduce evaluators to RDS principles and procedures; and (2) using RDS in the context of assessing program consumer needs. The RDS methodology is briefly described and followed by the case study example.

Respondent-driven sampling

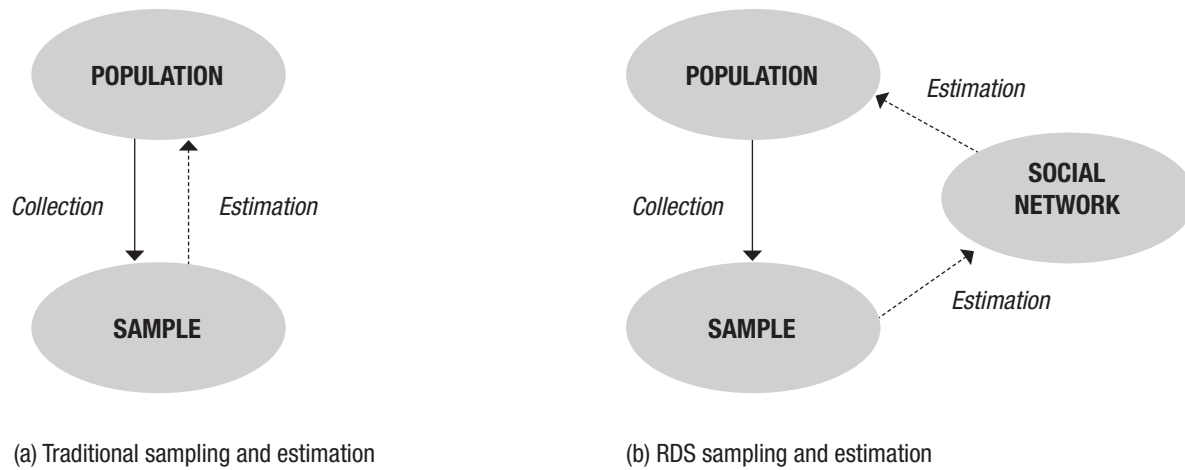
RDS principles and procedures

Traditionally, researchers have relied on chain-referral sampling (a.k.a. snowball sampling) to estimate population statistics for hidden populations. Chain-referral sampling is a nonprobabilistic method in which members of a hidden, rare, or hard-to-reach population are asked to provide referrals to other members of their group. Typically, this process continues until a desired sample size is reached or an entire network of the population is sampled. While this method can rapidly identify a pool of potential participants, it introduces a sampling bias because it violates the equal probability of selection principle.² This means that the relationship between the sample and the population from which it was drawn becomes more difficult to estimate statistically. Consequently, one loses the ability to generalize results to the population with a high degree of confidence.

RDS is designed to overcome the limitations associated with chain-referral types of sampling (Biernacki & Waldorf 1981), while maintaining the advantages of chain-referral sampling's broad coverage and ease of implementation (Salganik & Heckathorn 2004). Moreover, rather than estimating from the sample to the population, RDS relies on information about the social network (see Figure 1) to draw these estimates (Heckathorn 1997, 2002).

Like chain-referral approaches, RDS is premised on the assumption that group members can most efficiently and effectively identify other group members (Salganik & Heckathorn 2004). However, probabilities of selection are determined using RDS, which is a probability sampling method

FIGURE 1: TRADITIONAL AND RDS SAMPLING AND ESTIMATION



Source: Salganik, MJ & Heckathorn, DD 2004, 'Sampling and estimation in hidden populations using respondent-driven sampling', *Sociological Methodology*, vol. 34, no. 1, pp. 193–240.

(Heckathorn 1997, 2002). Thus, RDS disputes the argument that snowball-type methods (Atkinson & Flint 2001) are merely samples of convenience. RDS is a member of a class of sampling methods termed 'link-tracing/adaptive sampling designs' (Félix-Medina & Thompson 2004) that are designed to be used in settings where traditional probability sampling methods are infeasible.

Similar to other chain-referral methods, RDS utilizes an initial group of participants (i.e. the RDS seeds) to recruit members from the hidden population. The initial RDS seeds are selected based upon previous contact with the target population. These seeds are paid to be interviewed and recruit new participants, who are also paid. This process is repeated until the desired sample size is reached and the sample composition stabilizes with respect to the traits upon which the evaluation is focused. Equilibrium is attained when the traits of the sample converge on those of the population (Salganik & Heckathorn 2004). At this point, the sample composition is independent of the seeds from which sampling began. Therefore, RDS overcomes the sampling bias (i.e. the lack of statistical independence between recruiters and those recruited) that plagues chain-referral sampling.

In addition to reaching equilibrium, conducting several sampling waves also allows evaluators to reach population members who have little contact with other group members (Salganik & Heckathorn 2004). Therefore, an important design element in RDS involves techniques for increasing the length of referral chains. To produce long chains requires that respondents be recruited by their peers rather than by the evaluator, providing rewards or incentives for peer recruiters, and setting quotas for recruiters.

The RDS sampling frame

Social network theory is a branch of social science that attempts to map the relationship that exists between people or groups. RDS provides a means of mapping these relationships by determining the proportional size of a population and its internal structure (DiMaggio 2000). To implement RDS, one must be able to document the referral network. This is accomplished by using marked coupons that identify the recruiter. Sampling frames are constructed by providing incentives to seed recruiters. In turn, these seeds recruit members from their group who become the next round of recruiters. In order to limit the influence of recruiters with large social networks, only a limited number of coupons are provided to each recruiter. Relative inclusion probabilities are calculated using the statistical theory upon which RDS is based. This occurs only after sampling has been completed—a process known as 'post-stratification' (Salganik & Heckathorn 2004). These probabilities are calculated based on the following information:

- Who recruited whom? This provides the basis for controlling for bias introduced by the tendency of subjects to recruit those like themselves.
- How well connected is each respondent within the target population; that is, what is the subject's personal network size?
- Do the recruiter and recruit know one another, or are they strangers?

(Adapted from Salganik & Heckathorn 2004)

RDS estimations and parameters

As a detailed presentation of the statistical theory on which RDS rests would exceed the scope of this article, the rationale upon which it is based can be summarized as follows:

- Some recruiters recruit more effectively than others do. Consequently, the distinctive recruitment patterns of these ‘super’ recruiters may become overrepresented in the sample. Therefore, the RDS population estimator projects what the sample composition would have been, if all groups had recruited equally.
- Similarly, some individuals are more insular than others are. As a result, they tend to recruit individuals with very similar traits and characteristics (e.g. race, sociodemographic) to themselves. This type of ‘inbreeding’ may result in oversampling of certain groups. The RDS population estimator projects what the sample composition would have been, if all groups possessed equal homophily—similar traits and sociodemographic characteristics.
- Larger network groups are oversampled, because more recruitment paths lead to their members, than to groups whose members are less well connected. The RDS population estimator projects what the sample composition would have been, if all groups had equal network sizes.

For complete information on estimating population parameters for a RDS see Salganik and Heckathorn (2004). RDS software, capable of estimating these parameters and statistics, is freely available at <<http://www.respondentdrivensampling.org>>.

The case study

Context of the case study

The program evaluated was a collaborative partnership between four human and social service agencies in the community. This collaboration was established to address a surge in the number of individuals and families in the area seeking emergency housing and shelter and various forms of public assistance. This rise in demand was partially attributed to the recent increase in unemployment. The area unemployment rate had already been substantially higher than state and nation averages, and was compounded by recent closures of several important local industry sectors, which employed primarily low or unskilled labor.

These local statistics, coupled with expert knowledge, supported the collaboration’s goals of assisting these persons in obtaining and maintaining self-sufficiency (via housing and employment), with the intent of reducing homelessness in the area. Although the collaborative program was relatively new (less than five-years old), they requested an evaluation which was both formative and summative; for purposes

of identifying areas for program improvement as well as for purposes of accountability.

The first phase of the evaluation was to conduct a needs assessment of the program’s target population. As previously discussed, this assessment was to serve several purposes: (1) to estimate the prevalence of homelessness in the area; (2) to identify the needs of the target population; (3) to identify one set of the relevant evaluative criteria by which the program would be evaluated; and (4) to collect baseline data on key outcome variables. Prior to conducting the actual needs assessment, interview surveys were piloted on a small number of program recipients for validation and refinement.

The needs assessment

The needs assessment was conducted by means of a four-phase process. The first phase was the initial seed selection, in which the seeds to form wave 0 of the RDS were selected. The second phase consisted of subsequent RDS recruitment waves and data collection. The third and fourth phases were for estimating social network and population parameters. Each phase of the RDS procedure for the needs assessment is presented briefly, followed by a short discussion of the emergent findings (i.e. various aspects of need, baseline data, relevant evaluative criteria).

In addition to the RDS procedure, secondary data on needs of the homeless were collected via literature reviews, expert informants, and program personnel. It should be noted that throughout this assessment that a definition of homeless (Legal Information Institute 2005; McKinney-Vento Act 1987) was used, which states: (1) an individual who lacks a fixed, regular, and adequate nighttime residence; and (2) an individual who has a primary nighttime residence that is (a) a supervised publicly or privately operated shelter designed to provide temporary living accommodations (including welfare hotels, congregate shelters, and transitional housing for the mentally ill); (b) an institution that provides a temporary residence for individuals intended to be institutionalized; or (c) a public or private place not designed for, or ordinarily used as, a regular sleeping accommodation for human beings.

Phase 1: seed selection

The first phase in any RDS application is to select an initial set of seeds. Seeds should be selected based on: (1) diversity of demographic and geographic factors; (2) diversity on key outcome variables; and (3) commitment to the goals of the study. Only five seeds (20–25 are recommended) were selected to form wave 0, due to budgetary and time constraints.

Phase 2: recruitment waves

To achieve saturation (i.e. equilibrium)—the point at which the sample composition becomes stable—this application of RDS used dual incentives to encourage participation from the target population and to obtain adequately long chains

of referral. First, respondents were awarded US \$15 for participating in survey interviews. Second, respondents were given a reward for each peer they recruited; respondents were paid US\$15 for participating in a survey interview and an additional US\$10 for each person they recruited. Recruitment quotas for each seed and subsequent respondents were set at three. It was during the nine recruitment waves that needs and baseline data for outcomes were collected via the interview surveys.

As with most RDS applications, seeds and recruits were provided with paper recruitment coupons. The coupon included information on how to contact the evaluator and instructions for getting to the interview site. On each coupon was a unique numeric identifier, used for documenting who recruited whom, a crucial piece of information for calculating RDS population estimates.

Phase 3: social network estimates

As discussed previously, RDS analysis has unique data requirements. RDS analysis requires not only information on the focal variables (i.e. homelessness, needs, baseline data), but also two additional items of information that function to provide the sampling frame from which sample estimates are calculated: (1) cross-group recruitment patterns (e.g. proportional recruitment of homeless positives by homeless negatives, and recruitment of homeless negatives by homeless positives); and (2) estimated mean network sizes (e.g. the estimated mean network sizes of homeless positives and negatives).³

In the RDS, homeless positives made up only 16 of the 300 subjects recruited (5.3%), and homeless positives recruited other positives 11% of the time, while homeless negatives recruited homeless positives only 3% of the time. On the other hand, homeless positives recruited negatives 89% of the time, while homeless negatives recruited negatives 97% of the time. Moreover, homeless positives reported larger network sizes on average ($M = 4.6$) than homeless negatives ($M = 3.5$).

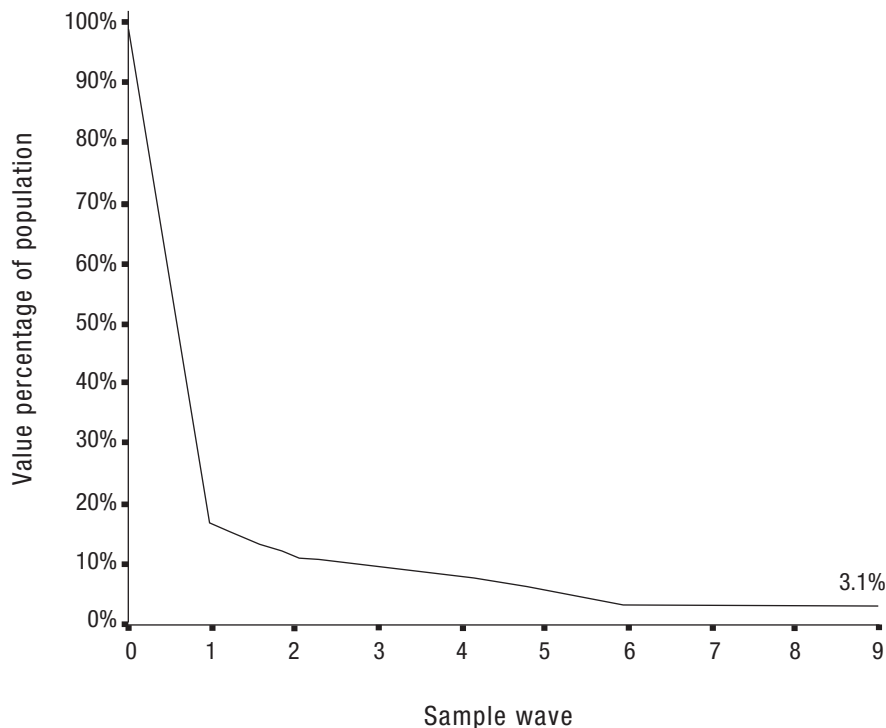
Phase 4: population parameters

The final phase in the RDS was to calculate population parameters. Figure 2 illustrates the RDS equilibrium process, based on the sample. At wave 0, 100% (all initial seeds) were homeless, but the percentage of homeless declined to 16.5% by wave 1, 11.3% by wave 2, 9.2% by wave 3, and stabilized at 3.1% by wave 5.

Equation 1a, where A = homeless positive, B = homeless negative, S_{ab} = the proportion of Bs selected for recruitment by As, and S_{ba} = the proportion of As selected for recruitment by Bs, N_a = homeless positive mean network size, and N_b = homeless negative mean network size, was used to estimate the proportion of As (homeless positive) in the population.

$$P_a = \frac{S_{ba}N_b}{S_{ba}N_b + S_{ab}N_a} \quad \text{Equation 1a}$$

FIGURE 2: SAMPLE COMPOSITION STABILIZATION AND EQUILIBRIUM



$$P_a = \frac{.0325 \times 3.5}{(.0325 \times 3.5) + (.8941 \times 4.6)} = .0269$$

Equation 1b

Entering the RDS data presented in Table 1 into equation 1a, the estimated prevalence (see equation 1b) of homelessness was 2.7% (± 1.7%). Further, the prevalence estimate (2.7%) very nearly approximated the equilibrium sample distribution (3.1%). Official estimates (using unknown sampling procedures) of the prevalence of homelessness in the program’s geographic area ranged from as low as 1% to as high as 9%.

Needs, baseline data, and evaluative criteria

In addition to the data for RDS analysis (homeless positive or negative, mean network sizes) additional data such as various aspects of met and unmet performance needs and baseline data on previously identified outcome measures were collected. From identified performance needs, evaluative criteria were developed which represented these needs for purposes of determining how well the program was meeting these needs. Each of these is briefly discussed in turn below.

Needs

During the course of the 10 RDS waves, respondents who were identified as homeless positive were surveyed regarding their needs under the auspices of attaining and maintaining self-

sufficiency and reducing their reliance on public assistance. Table 2 shows some of the performance needs that emerged from the survey interviews. Once these needs were identified and documented, the potential underlying causes of these needs were then investigated.

As can be seen in Table 2, underlying performance needs (i.e. obtaining and maintaining housing and employment and reduced reliance on public assistance), primarily centered on such things as substance dependence, health care, and education, for example. By identifying potential causes of these performance needs, the needs assessment component of the evaluation provided valuable information to the program regarding their intervention strategies, potential areas for improvement, and likely reasons for suboptimal performance where these needs were not being adequately met or addressed at all.

Baseline data

Given the program’s emphasis on attaining and maintaining self-sufficiency and reducing reliance on public assistance, baseline data for later use in the evaluation (e.g. outcomes) were collected during the 10 RDS waves from respondents who were identified as homeless positive. These data centered primarily on goal-based objectives of the program (e.g. dollar amounts of public assistance received, duration and frequency of homelessness).

Evaluative criteria

The final step was to identify relevant evaluative criteria based on the performance needs of the program’s target population. Referring back to

TABLE 1: HOMELESS STATUS OF RDS RECRUITS

Selection proportion	Homeless status of recruits			Local estimates
	<i>Negative</i>	<i>Positive</i>	<i>Total</i>	
Negative	208	7	215	
Row (%)	(0.9674)	(0.0325)	(1)	
Positive	76	9	85	
Row (%)	(0.8941)	(0.1058)	(1)	
Total recruits	284	16	300	
Row (%)	(0.9466)	(0.0533)	(1)	
Equilibrium	0.9689	0.0311	1	
Estimated mean network size (N)	3.5	4.6		
Population estimate (P)	0.9731 (97.3%)	0.0269 (2.7%)		0.0500 – 0.0900 (5% – 9%)
Standard error of P	0.0173	0.0173		

TABLE 2: EXAMPLES OF PERFORMANCE NEEDS AND THEIR POTENTIAL CAUSES

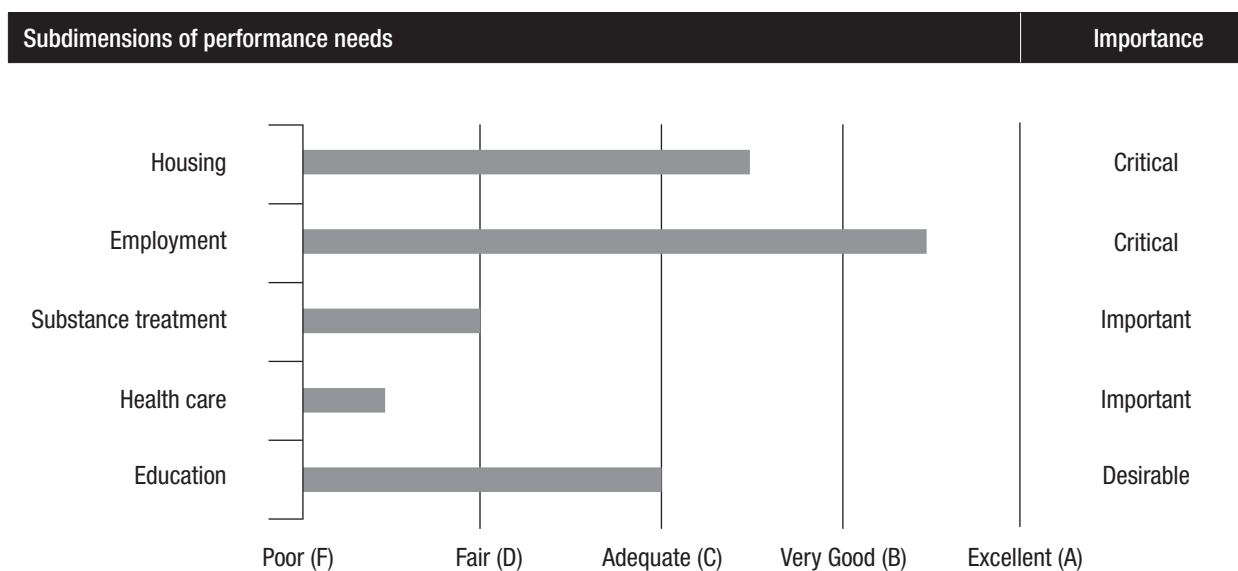
Performance needs	Potential causes
Housing	Lack of resources (e.g. temporary or emergency housing/shelters), skill deficit (e.g. money management)
Employment	Skill deficit (e.g. poor work history, lack of adequate job skills), lack of resources (e.g. availability of low-skilled or entry-level positions; transportation)
Substance treatment	Lack of resources (e.g. treatment programs), lack of intrinsic and/or extrinsic motivation
Health care	Lack of resources (e.g. insurance, free or low-cost clinics)
Education	Skill deficit (e.g. low levels of literacy and or completion of primary education) and lack of extrinsic and/or intrinsic motivation (e.g. education is not perceived as valuable)

Table 2, a criterion list based on the examples of the target population’s performance needs was developed, including rubrics for assessing the program’s performance on these dimensions. Over the course of the evaluation, these criteria or dimensions of merit were then rated, as illustrated in Figure 3. Importance weights assigned to the subdimensions of performance needs were determined both through the assessment of the target population and stakeholder involvement. Although these criteria were but one set of dimensions on which the program was evaluated, it was a crucial element of the overall evaluation.

Closing remarks

The introduction of a new method obligates the evaluator to be prepared to argue its merits over alternative methods. RDS offers a valuable methodological resource for evaluators, particularly for those who evaluate programs whose target populations are hidden. RDS improves upon the limitations of gathering samples of convenience (e.g. sampling homeless populations by sampling people at soup kitchens and homeless shelters) by building upon the advantages of chain-referral sampling (e.g. it provides a sample that is broader than purposive samples; it provides information on

FIGURE 3: EXAMPLES OF RATINGS ON PERFORMANCE NEEDS SUBDIMENSIONS



social networks). In addition, RDS has the added advantages of deriving asymptotically unbiased population parameters and being easily adapted and applied to non-, quasi-, or experimental studies for outcome evaluation or other purposes. Although it may not be necessary or desirable to use RDS in all evaluative contexts, it does allow evaluators to consider those who a program could potentially serve, as well as those who are actually being served where traditional sampling is not a viable option. This is particularly relevant in the case of determining to what extent a program is meeting the needs of its target population.

Historically, needs assessments have been seen primarily as a mechanism for program planning or development (Altschuld & Witkin 2000; Chen 2005; Witkin & Altschuld 1995), securing funding for programming interventions, and/or for justifying a program's existence (Rossi, Freeman & Lipsey 1999). However, needs assessments serve other critical, often overlooked purposes. First, these needs may serve as the basis for one set of evaluative criteria or dimensions of merit (Davidson 2005), without which a program cannot be comprehensively evaluated. Second, evaluating only goal-based elements (e.g. organizational goals and objectives) of a program often excludes crucial dimensions derived through the program's actual and potential consumer needs.

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Notes

- 1 A performance need is a state or benchmark that enables proper or adequate functioning on some dimension (Davidson 2005). For example, one must correctly estimate one's personal income tax in order to avoid penalties.
- 2 The equal probability of selection principle states that a sample will be representative of the total population if every member of the population has an equal chance of being included in the sample (Newport, Saad & Moore 1997).
- 3 Part of RDS is the analysis of the network composition of recruiters and those recruited; therefore, 'homeless positives' were persons recruited who met the criteria for 'homelessness' describe previously, whereas 'homeless negatives' were persons recruited who do not meet this criteria.

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